

Claims

- [1] 1. A light emitting diode including a substrate, a N-type semiconductor layer, an active layer for generating light, and a P-type semiconductor layer, the light emitting diode comprising:
- a first exposed region formed by etching the active layer and the P-type semiconductor layer to expose at least a part of the N-type semiconductor layer;
 - a first ohmic electrode formed on the first exposed layer;
 - a second ohmic electrode formed on the P-type semiconductor layer and having an opening at least a part of said P-type semiconductor layer having a second exposed region through said opening; and
 - said at least a part of P-type semiconductor layer being provided with an ultra-fine prominence and depression structure.
2. The light emitting diode as claimed in claim 1, wherein at least a part of the first exposed region excepting a portion having the first ohmic electrode has an ultra-fine prominence and depression structure.
3. A light emitting diode including a substrate, a N-type semiconductor layer, an active layer for generating light, a P-type semiconductor layer, a transparency metal(electrode), and a metal pad for wire bonding the light emitting diode comprising:
- a first exposed region formed by etching the active layer and the P-type semiconductor layer to expose at least a part of the N-type semiconductor layer;
 - a first ohmic electrode formed on the first exposed layer; and
 - at least a part of said first exposed region excepting a portion having the first ohmic electrode being provided with an ultra-fine prominence and depression structure.
4. The light emitting diode as claimed in any one of claims 1 - 3, wherein the P-type semiconductor layer is GaN doped with Mg the N-type semiconductor layer is GaN doped with S, and the active layer is GaN.
5. The light emitting diode as claimed in any one of claims 1 - 3, wherein the ultra-fine prominence and depression structure is a cluster of cylinder type prominence and depression elements.
6. The light emitting diode as claimed in claim 5, wherein the cylinder type prominence and depression element is a cone type, a column type, or a column type having a depressed upper end.

7. The light emitting diode as claimed in claim 5, wherein a width of the cylinder type prominence and depression element is $0.005 \sim 3 \mu\text{m}$, and a height is $0.1 \sim 1 \mu\text{m}$.
8. The light emitting diode as claimed in claim 5, wherein a width of the cylinder type prominence and depression element is $0.01 \sim 0.5 \mu\text{m}$, and a height is $0.2 \sim 0.7 \mu\text{m}$.
9. The light emitting diode as claimed in claim 5, wherein a width of the cylinder type prominence and depression element is $0.01 \sim 2$ times larger than a peak wavelength of the light emitting diode, and a height is $0.5 \sim 10$ times larger than the peak wavelength.
10. The light emitting diode as claimed in claim 5, wherein a width of the cylinder type prominence and depression element is $0.1 \sim 1$ times larger than a peak wavelength of the light emitting diode, and a height is $1 \sim 3$ times larger than the peak wavelength.
11. The light emitting diode as claimed in claim 5, wherein a density of the cylinder type prominence and depression elements is $1 \sim 10000/\mu\text{m}^2$.
12. The light emitting diode as claimed in claim 5, wherein a density of the cylinder type prominence and depression elements is $50 \sim 500/\mu\text{m}^2$.
13. The light emitting diode as claimed in claim 5, wherein the cylinder type prominence and depression element is formed by depositing a metal or silicon compound on the semiconductor layer, heat-treating the deposited metal or silicon compound, and dry- or wet-etching the deposited metal or silicon compound.
14. The light emitting diode as claimed in claim 13, wherein the metal is any one or combinations selected from a group of Ag, Al, Au, Cr, In, Ni, Pd, Pt and Ti.
15. The light emitting diode as claimed in claim 13, wherein a temperature for the heat-treating is ranged from 90°C to 400°C .
16. The light emitting diode as claimed in claim 15, wherein the cylinder type prominence and depression element is formed by selectivity, said selectivity being partly changed due to a reaction of the metal and the semiconductor at time of etching.